UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

MEMORANDUM

SUBJECT: **Lindane Food Chain Bio-Accumulation, -Magnification and -Concentration**
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TO: B. Shackleford, Branch Chief
M. Howard, Team Leader
Special Review and Reregistration Division (7508C)

FROM: ERB V RED Team for Lindane:
N.E. Federoff, Wildlife Biologist, Ecological Effects Reviewer, Team Leader
F.A Khan, Ph.D., Environmental Scientist
Environmental Fate and Effects Division (7507C)

THROUGH: Mah T. Shamim, Ph.D., Chief
Environmental Risk Branch V-EFED (7507C)

Lindane Food Chain Bio-Accumulation, -Magnification and -Concentration

Due to extensive use over the past 50 years, lindane is present in most environmental media and biological compartments and is present in terrestrial and aquatic food chains. However, evidence suggests that concentrations have been gradually decreasing. Recent data suggest that the declines of α-HCH isomer concentrations in the environment have resulted from reduced use of technical HCH, especially in Asian countries (Iwata et al., 1993). The behavior of HCH isomers in the environment is complex because they are multimedia chemicals, existing and exchanging among different compartments of the environment such as atmosphere, surface water, soil and sediment. In addition, temperature, humidity, and other environmental properties, may have significant influence on environmental degradation rates. The most common isomers found in the environment are lindane (γ-), α-, and β-HCHs, with α-HCH as the predominant isomer in air and ocean water and β-HCH the predominant isomer in soils, animal tissues and fluids (Willett et al., 1998). The physical and chemical properties of the HCH isomers can be quite different from one another. For example, β-HCH has a lower vapor pressure and a higher bio-concentration factor in fat than either α-HCH or lindane. In contrast, lindane and α-HCH seem to be more volatile than β-HCH (Willett et al., 1998). These properties likely reflect some of the differences seen in HCH isomer persistence and variability in bio-magnification, -concentration and -accumulation in the various biological compartments. Differences in accumulation are also likely due to different modes of uptake, metabolism and sources of contamination.

Bio-concentration factors (BCF) for Lindane were 780x in fillet, 2500x in viscera and 1400x in whole fish. It would seem this is partly due to high lipid solubility. Lindane can become enriched in lipid-containing biological compartments. However, although lindane may bioconcentrate rapidly, most data suggest bio-transformation, depuration and elimination are relatively rapid once exposure is eliminated. After a 28 day exposure and 14 days of depuration, levels were reduced by 96%, 95% and 85% in fillet, viscera and in whole fish, respectively.

HCH bio-accumulation/food chain data from Russia (Moisey et al 2001) and from Central/Western Canada (Kelly and Gobas 2001) suggests that β-HCH does bio-accumulate/bio-magnify, alpha does also, but at a lower level, and gamma (Lindane) the least. Data from Moisey et al (2001) suggests that the relative proportions of HCH isomers varied dramatically across species in the arctic marine food web studied. Kelly and Gobas (2001) indicate that the fugacity of lindane decreases with increasing trophic level suggesting trophic dilution (the lichen-caribou-wolf food chain was studied). It appears that upper trophic level mammals may be able to efficiently eliminate lindane and to a smaller extent α-HCH, but not β-HCH. In birds, β-HCH seems to have a tendency to accumulate to a greater extent than the other isomers, which may be due to consuming contaminated prey (Elliot et al., 1989), although concentrations have been on the decline. Even though concentrations of HCH isomers were detected in surface waters of the Arctic, bioaccumulation in the aquatic food chains was significantly less than the other organochlorine compounds (Norstrom and Muir, 1994) analyzed.

In conclusion, although there is evidence that HCH isomers can and do bio-magnify, bio-concentrate and bio-accumulate in different biological compartments and at different rates, the overall magnitude is an uncertainty. Overall, lindane seems to accumulate environmentally but generally to a lesser extent than either the alpha, and especially, the beta isomers. Generally, Lindane tends to bio-magnify in lower trophic levels where bio-transformation was minimal, although not to the extent α-HCH does. β-HCH tends to mainly bio-accumulate in upper trophic levels (fish, birds, mammals) at higher concentrations.

Literature Cited

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